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Abstract

SOME FUNDAMENTAL ASPECTS OF BOILING IN NUCLEAR REACTORS

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The main results obtained at Grenoble during the last four years in the field of boiling mechanisms and related phenomena in nuclear reactors are reported.

1. OBSERVATION OF BOILING.

By the use of photography and ultrafast cinematography (8000 frames per second maximum), boiling in a vessel or a tube was observed up to 140 kg/cm^2 .

The populations of bubble-generating seeds (sites) were counted, and a correlation established giving their number per unit of surface area as a function of the thermal flux and the pressure.

The diameter of the bubbles breaking off from the wall was studied up to 140 kg/cm^2 : three types of bubble have been shown to exist:

- those in equilibrium, their diameter following the formula of Fritz and Ende.
- bubbles founed by boiling, the diameters of which decrease rapidly with the pressure ($1/100 \text{ mm}$ to 100 kg/cm^2).
- the coalescences which appear in saturated liquid above 15 W/cm^2 , their proportion being independant of the pressure.

Strioscopic observations were made of the movements of the thermal film associated with the generation of the seeds, at the initiation and condensation of the bubbles ; the mechanisms responsible for the highly efficient heat transfer could thus be defined.

2. PRESSURE LOSSES IN TWO-PHASE FLOW.

A physical model of the continuous variation of the free space content in a boiling channel has been proposed by means of which the pressure losses can be calculated without invoking a break in the coefficient of friction when free boiling begins. Agreement between theory and experiment is satisfactory.

The various forms which total pressure loss in a boiling tube may present as a function of flowrate have been studied. Special features are observed at very low and very high speeds.

3. BURN-OUT.

Under steady operating conditions, it is shown that in a uniformly heated channel the burn-out flux as a function of output rate is generally independent of the length.

When burn-out is a result of output oscillation, the conditions of burn-out are compared with those obtained under steady conditions.

The burn-out flux following uniform "stopped" heating has been studied in a channel containing still water. The flux shows a maximum as a function of unsaturation. The influence of the geometry and the nature of the metal was investigated.

4. OUTPUT OSCILLATIONS.

Using a low pressure (8 atm) loop, the influence of various parameters on the periods of output oscillations in a boiling channel on the thresholds at which they appear, was studied.

Some new aspects of this complex phenomena were observed and are reported.